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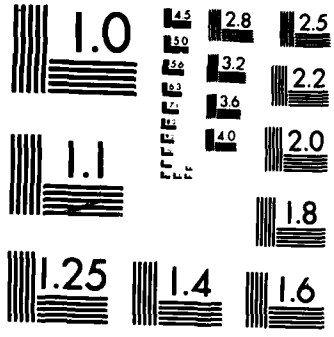

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VOICE CONTROL OF AN UNMANNED SUBMERSIBLE

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AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

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ADMINISTRATIVE INFORMATION

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The advantages of voice control of the movement of an unmanned, remotely controlled submersible and the feasibility of such a system are discussed. Application of voice control to the Fiber Optic Controlled Underwater Stereo (FOCUS) vehicle is described and an associated computer program listing presented.

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CONTENTS

ILLUSTRATIONS

INTRODUCTION

There are several remote unmanned submersibles which are under development or have been proposed. They all require manual vehicle control while simultaneously requiring operator control or attention to other tasks such as operating the search sonar, grabber, manipulator, etc. It became apparent that if voice control over the movement of these vehicles could be accomplished, the operator would have greater freedom to concentrate efforts on the more demanding tasks requiring immediate attention.

The remote unmanned submersible selected for voice control implementation was the Fiber Optic Controlled Underwater Stereo (FOCUS) vehicle. This vehicle was selected because of its availability and its ongoing development. Figure 1 shows a block diagram of the voice control FOCUS system.

BACKGROUND

The FOCUS vehicle (see figure 2) is a remote unmanned submersible which is controlled over a single fiber optic cable. The fiber optic cable carries all of the instrumentation and control signals required to operate and monitor the vehicle. The vehicle carries two T.V. cameras, giving it a

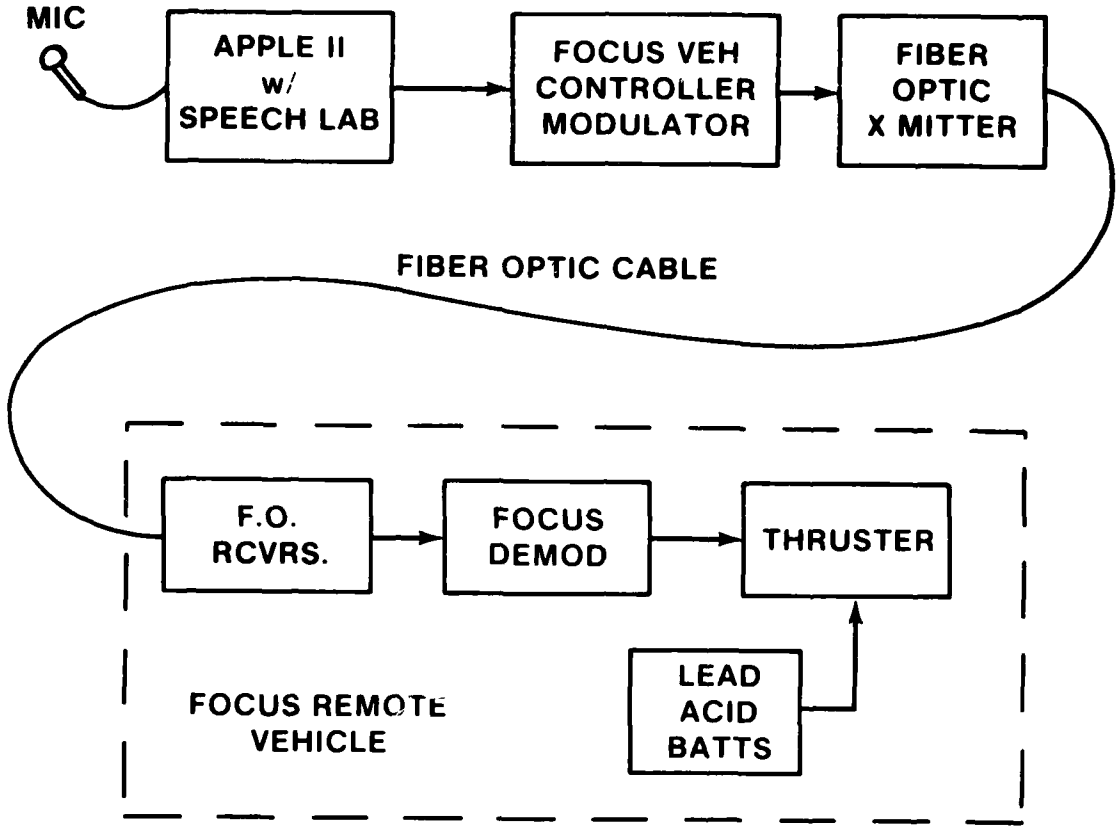


Figure 1. Voice Control Block Diagram.

Figure 2. FOCUS Vehicle

stereo viewing capability, and a scanning obstacle avoidance sonar for navigation and search. Propulsion is furnished by two horizontal and one vertical thruster. The power required to operate the vehicle is furnished by eight lead-acid batteries which are housed in four pressure housings.

OBJECTIVE

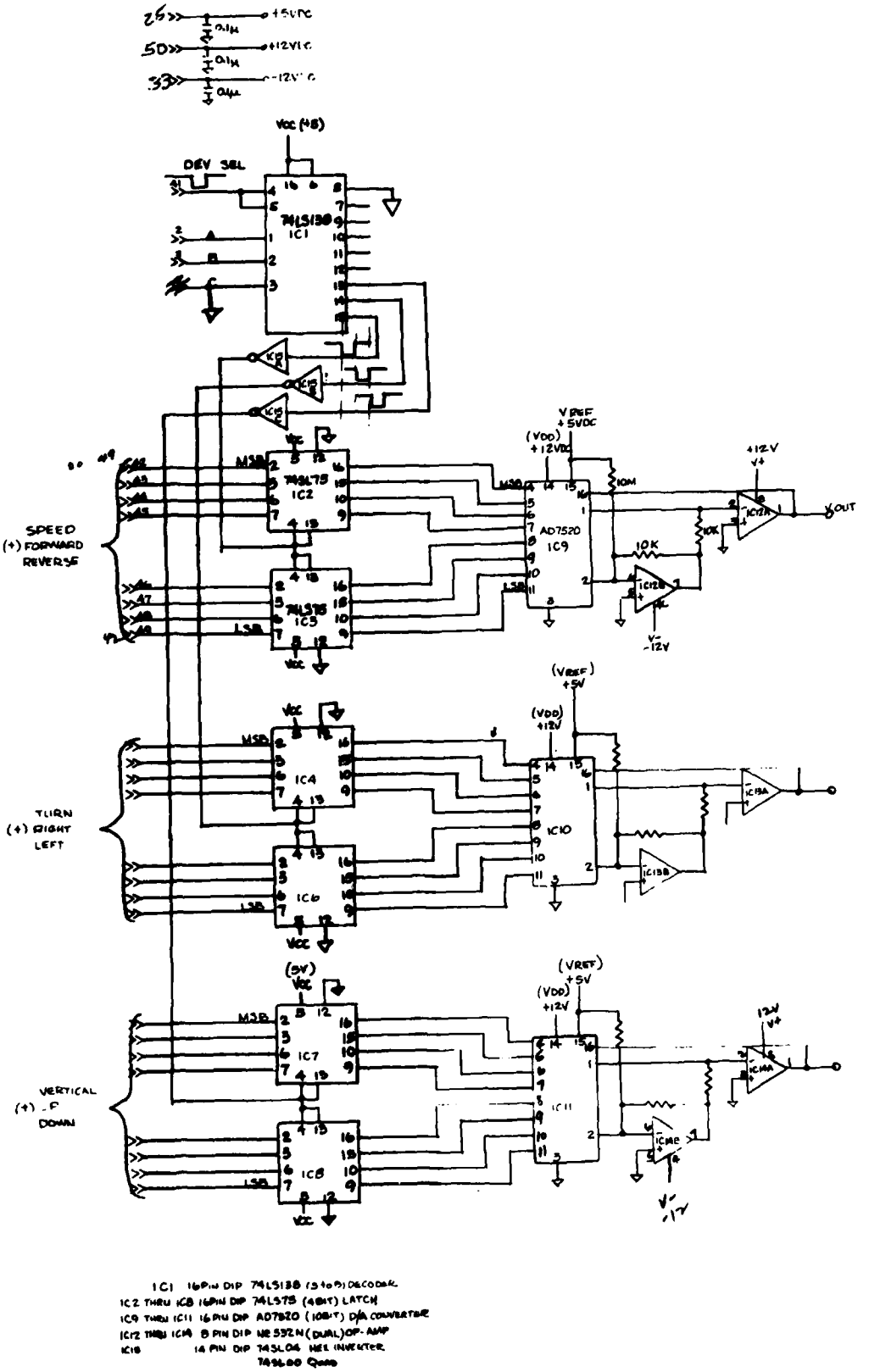
The objective of this project is to demonstrate the advantages of voice control on a remote controlled submersible and show its feasibility.

APPROACH

The FOCUS vehicle requires three input command channels. The commands control: (a) Speed (forward, reverse), (b) Turn (left, right), and (c) Vertical (up, down).

An Apple II computer with a speech recognition peripheral was purchased to be the voice recognition control system. A computer to fiber optic telemetry interface circuit (see figure 3) was designed and fabricated on an Apple computer hobby board for installation in the computer.

The computer (see figure 4) recognizes the command and speed, then outputs signals to the respective thrusters through the interface circuit. The software (see Appendix A) has been developed to interface with the speech recognition



IC1 16Pin DIP 74LS138 (3 to 8) DECODER
IC2 THRU IC8 16PIN DIP 74LS75 (4BIT) LATCH
IC9 THRU IC11 16 PIN DIP AD7820 (10BIT) D/A CONVERTER
IC12 THRU IC14 8 PIN DIP NE 532 N (DUAL) OP-AMP
IC15 14 PIN DIP 74SL04 HEX INVERTER
74SL00 Quad

Figure 3. Computer Interface Circuit.

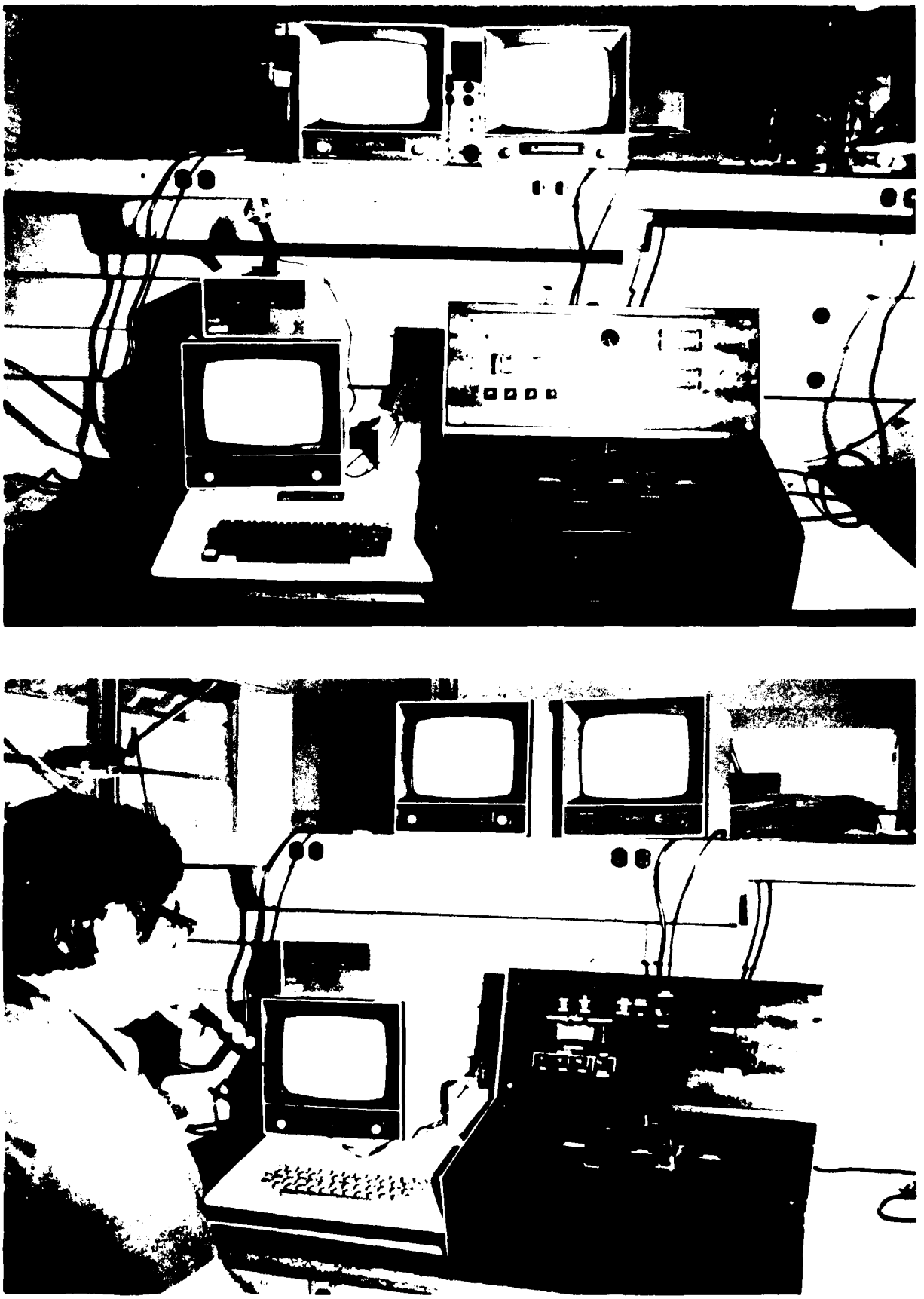


Figure 4. Computer and Control Console.

peripheral to which control is passed when commands are input. The peripheral has two modes of operation: (1) a training mode in which examples of each word are provided; and, (2) a recognition mode in which previously trained words are recognized. The peripheral executes its own program, which is independent and unchangeable, to determine which of the previously trained words were spoken. It then outputs the recognized word and returns the control to the original program. Three commands, direction, speed, and execute are entered sequentially in the program. The direction command must be recognized before a speed command can be entered and the speed command must be recognized before the execute commands can be entered. The direction commands used are: AHEAD, BACK, PORT, STARBOARD, UP, DOWN, and ALL STOP. The speed commands are: ONE/THIRD, TWO/THIRDS, FULL and ZERO. The execute commands are GO (for execute) and IGNORE. IGNORE will cancel all previous inputs.

CONCLUSION

The testing done with voice control on the FOCUS vehicle demonstrated the feasibility of voice control on remote unmanned submersibles. Due to the late start of the program, extensive operator tests were not run. However, the subjective responses

of the operators during the testing that did occur were positive. The vehicle could easily be controlled and learning to use the voice control was simple.

APPENDIX A

VOICE CONTROL SOFTWARE

```
 10 Poke 74, 124: Poke 204, 124: Poke 75, 21: Poke 205, 21.

 15 REM Set Lomen:  5500 for speechlab program

 20 Call -936: dim ß$ (15, FA (3), FB (3), FC (3)

 30 Print: Print "TO CONTROL THE FOCUS VEHICLE,": Print:
    Print "THE OPERATOR MUST GIVE A COMMAND,"

 40 Print: Print "SPEED, and EXECUTION.  The command":
    Print: Print "AND SPEED ARE PRINTED OUT FOR YOUR"

 50 Print: Print "CONVENIENCE. If the Command or": Print:
    Print "SPEED PRINT OUT IS INCORRECT,"

 60 Print: Print "USE 'IGNORE' to delete the command.":
    Print: Print "IF THE COMMAND AND SPEED ARE CORRECT,"

 70 Print: Print "EXECUTE WITH 'GO' STATEMENT.": Print:
    Print

 80 Input "TYPE 'GO' to begin voice control program.", ß$

 90 Slot 1 - 3: REM speechlab slot

 95 Slot 2 - -16160: REM Focus Address

100 FA = Ø:  REM ahead/back flag

105 FB = Ø:  REM port/starboard flag

110 FC = Ø:  REM down/up flag

115 F1 = 128:REM halt (1000) (ØVDC)

120 F2 = 255:REM neg full (1111) (5VDC) (235 approx - 4VDC)

125 F3 = 192:REM neg half (1100) (2VDC)

130 F4 = 144:REM neg slow (1001) (.9VDC)

135 F5 = 1: REM plus full (0000) (5VDC) (20 approx 4VDC)

140 F6 = 64: REM plus half (0100) (2VDC)

145 F7 = 106:REM plus slow (0110) (.9VDC)

160 DIM C$ (15), W$ (15), A (3), B (3), C (3)

170 Gosub 9000: REM init speechlab
```

```
180 Call -936: Print "THIS IS A PROGRAM TO CONTROL": Print:
    Print "THE FOCUS VEHICLE BY VOICE COMMANDS."

190 Print: Print "COMMANDS ARE: AHEAD-BACK-STARBOARD": Print:
    Print "PORT-UP-DOWN-ALLSTOP."

200 Print: Print "Speeds are: ONE/THIRD, TWO/THIRDS": Print:
    Print "FULL-ZERO.": Print: Print "FIRST, WE TRAIN THE
    SYSTEM.": Print: Print

210 Input "Type 'GO' to start the program:" W$

220 For I - 1 to 2

230 W$ = "ALL STOP": Print "SAY:"; W$: GOSUB 9100

240 W$ = "GO": Print "SAY:"; W$: GOSUB 9100

250 W$ = IGNORE": Print "SAY:"; W$" GOSUB 9100

270 W$ = "BACK": Print "SAY:"; W$: GOSUB 9100

280 W$ - "STARBOARD": Print "SAY:"; W$: GOSUB 9100

290 W$ = "PORT": Print "SAY:"; W$: GOSUB 9100

300 W$ = "UP": Print "SAY:"; W$: GOSUB 9100

310 W$ = "DOWN": Print "SAY:"; W$: GOSUB 9100

320 W$ = "ONE/THIRD": Print "SAY:"; W$: GOSUB 9100

330 W$ = "TWO/THIRDS": Print "SAY:"; W$: GOSUB 9100

340 W$ = "FULL": Print "SAY:"; W$: GOSUB 9100

345 W$ = "ZERO": Print "SAY:"; W$: GOSUB 9100

350 NEXT I

360 Call -936: Print: Print "THE SYSTEM IS NOW READY."

370 Print: Print "THE FOCUS VEHICLE WILL NOW OBEY": Print:
    Print "YOUR COMMANDS.": Print: Print

380 Input "TYPE 'GO' to begin operation.", W$

390 GR: color = 15

400 Call -936: Print "COMMAND PLEASE": GOSUB 9200: REM get
    a command
```

```
410 C$ = W$: A=FA: B=FB: C=FC
420 Call -936: Print C$
430 If W$ = "ALL STOP" then 9250
440 Al = Slot 2
450 If W$ = "AHEAD" then 600
460 If W$ = "BACK" then 610
470 Al = Slot 2 + 1:
480 If W$ = "STARBOARD" then 630
490 If W$ - "PORTP then 620
500 Al = Slot 2 + 2:
510 If W$ = "UP" then 650
520 If W$ = "DOWN" then 640
530 Print: Print "DID NOT UNDERSTAND YOU"
540 For I = 1 to 300: NEXT I
550 GOTO 400
600 FA = 1: GOTO 9300
610 FA = -1: GOTO 9400
620 FB = 1: GOTO 9300
630 FB = -1: GOTO 9400
640 FC = 1: GOTO 9300
650 FC = -1: GOTO 9400
```

```
 700 GR: Color = 15
 710 If FA = 1 Then 9600
 720 If FA = -1 Then 9610
 730 If FB = 1 Then 9630
 740 If FB = -1 Then 9620
 750 If FC = 1 Then 9650
 760 If FC = -1 Then 9640
 770 GOTO 400


9000 REM init speechlab
9010 PR#Slot 1: Print: PR #Ø: RETURN

9100 REM Train Routine: ARG = W$
9110 PR# Slot 1: Print W$:PR#Ø: RETURN

9200 REM recognize routine
9210 In #Slot 1: Input W$
9220 PR #Ø: In #Ø: RETURN
9250 POKE SLOT 2, F1: Poke slot 2 + 1, F1: Poke slot 2+2, F1:
     GR: color = 15: HLIN 4, 6 at 5: VLIN 4, 6 at 5
9260 FA = Ø: FB = Ø: FC = Ø
9270 Print Slot 2, Slot 2 + 1,  Slot 2+2: Print F1, F1, F1:
     For I = 1 to 200: NEXT I
9280 GOTO 400

9300 REM Plus speed routine
9305 Call -936: Print C$
9310 Print: Print "SPEED PLEASE": GOSUB 9200
```

```
9315  If W$ = "IGNORE" then 9560
9320  D1 = F7
9325  If W$ = "ONE/THIRD" then 9500
9330  D1 = F6
9335  If W$ = "TWO/THIRDS" then 9500
9340  D1 = F5
9345  If W$ = "FULL" then 9500
9350  D1 = F1
9355  If W$ = "ZERO" then 9570
9360  Print: Print: Print "SPEED UNKNOWN": For I = 1 to 300:
      Next I
9365  GOTO 9300
9400  REM Neg Speed routine
9405  Call -936: Print C$
9410  Print: Print "SPEED PLEASE": GOSUB 9200
9415  If W$ = "IGNORE" then 9560
9420  D1 = F4
9425  If W$ = "ONE/THIRD" then 9500
9430  D1 = F3
9435  If W$ = "TWO/THIRDS" then 9500
9440  D1 = F2
9445  If W$ = "FULL" then 9500
9450  D1 = F1
9455  If W$ = "ZERO" then 9570
9460  Print: Print: Print "SPEED UNKNOWN": For I = 1 to 300:
      Next I
9465  GOTO 9400
```

```
9500  Z$ = W$
9505  Call -936: Print C$, Z$
9510  GOSUB 9200: REM get execution statement
9520  If W$ = "IGNORE" then 9560
9530  If W$ = "GO" then 9550
9540  Print: Print: Print "ILLEGAL STATEMENT": For I = 1 to 300:
      Next I
9545  GOTO 9505
9550  Print: Print "COMMAND ACCEPTED": Print A1, D1: For I =
      1 to 200: Next I: Poke A1, D1
9555  GOTO 700
9560  Print: Print: Print "COMMAND IGNORED": For I = 1 to 300:
      Next I
9565  FA = A: FB = B: FC = C: GOTO 700
9570  If C$ = "AHEAD" then 9700
9575  If C$ = "BACK" then 9700
9580  If C$ = "STARBOARD" then 9710
9585  If C$ = "PORT" then 9710
9590  If C$ = "UP" then 9720
9595  If C$ - "DOWN" then 9720
9600  VLIN 1, 7 at 5: HLIN 4, 6 at 2: Plot 3, 3: Plot 7, 3:
      Plot 2, 4: Plot 8, 4: GOTO 730
9610  VLIN 9, 15 at 5: HLIN 4, 6 at 14: Plot 3, 13: Plot 7, 13:
      Plot 2, 12: Plot 8, 12: GOTO 730
9620  HLIN 5, 10 at 8: VLIN 7, 9 at 9: Plot 8, 6: Plot 8, 10:
      Plot 7, 5: Plot 7, 11: GOTO 750
9630  HLIN 0, 5 at 8: VLIN 7, 9 at 1: Plot 2, 6: Plot 2, 10:
      Plot 3, 5: Plot 3, 11: GOTO 750
```

```
9640  VLIN 35, 39 at 2: VLIN 35, 39 at 4: Plot 3, 39: GOTO 400
9650  VLIN 35, 39 at 4: VLIN 37, 39 at 2: Plot 3, 37: Plot 3,
      39: GOTO 400
9700  FA = Ø:  GOTO 9500
9710  FB = Ø:  GOTO 9500
9720  FC = Ø:  GOTO 9500
```


4-8
DTI